J. W. BRÜHL, from the results of determinations of molecular refractions of many carbon compounds, concluded that the atomic refraction of carbon varies according as the atoms of carbon are tetravalent, divalent, or monovalent (singly, doubly, or trebly "linked"), in the molecule under consideration. In calculating molecular refractions, Brühl used the empirical expression $\frac{n-1}{d}\cdot M$; Landolt has recently re-calculated the ratios of many molecular refractions by the use of the formula $\frac{n^2-1}{(n^2+2)d}\cdot M$, deduced by Lorenz from the theory of light; his results entirely confirm those arrived at by Brühl by the use of the empirical expression stated above

IN their researches on ozone, MM. Chappuis and Hautefeuille have made use of the spectroscope to trace the progress of the chemical change which occurs when oxygen, or a mixture of oxygen and nitrogen, is subjected to the action of the electric discharge. They find that ozone is characterised by a distinct absorptive spectrum, the prominent bands in which are two in number situated in the neighbourhood of D. The same bands are prominent in the absorptive spectrum of liquid ozone.

MM. CHAPPUIS AND HAUTEFEUILLE also find that the amount of ozone produced by the action of the electric discharge on a mixture of oxygen and nitrogen increases to a maximum, then decreases to a minimum, then again increases, and so on; by the aid of the spectroscopic method they trace this oscillation to the formation and decomposition of an oxide of nitrogen not hitherto observed, which they propose to call pernitric oxide (*acide pernitrique*) (*Compt. rend.*, xciv. 858 and 1111).

THE *Journal* of the Society of Chemical Industry, the fourth number of which is now before us, promises to be of very great service to all who are interested in chemical manufactures. The present number of the journal contains papers read before the Society on "Smoke Abatement," "The Chemical Technology of Jute Fibre," "The loss of Sulphuric Acid in the Manufacture of Salt Cake," &c. Notes on the more important recent technical applications of chemistry and chemical physics, and very useful classified abstracts of recent patents complete the number.

IN the last number of the *Berichte* of the German Chemical Society (xv. 1161) HH. v. Meyer and H. Goldschmidt describe an apparatus by means of which the specific gravities of gases may be determined at very high temperatures. The apparatus concists of a cylindrical porcelain tube 500 or 600 mm. in length, capacity about 100 c.c., furnished with a capillary tube of about 200 c.c. long at each end. The apparatus is heated, the air is driven out by an inert gas, *e.g.* by nitrogen, the gas whose specific gravity is required is allowed to enter the apparatus, and the weight of this gas is determined by driving it out, by means of an inert gas, into some liquid by which it is completely absorbed. The temperature may be calculated from the ratio between the volume of air contained in the apparatus under the conditions of the experiment and the volume contained at the ordinary temperature of the room. By the use of this apparatus the authors have determined that the density of cyanogen is normal (*i.e.* corresponds with the formula C_2N_2) between 100° and 800°, but that at 1200° this gas is decomposed with evolution of nitrogen.

PHYSICAL NOTES

A NEW method of comparing the brightness of different coloured lights has been proposed by Herr Brücke (*Wien. Ber.*, 84). He finds that objects cease to be visible at a greater visual angle, the more they differ from the background on which they are seen, only in colour and not in brightness. If a board be set up, which is black at one end and white at the other, with successive shades of grey between (a brightness-table), one may determine the brightness, *e.g.* of a coloured paper, by placing a piece of it before different parts of the board, and noting the place where, with shortest interval, it becomes invisible. This relation of brightness, in red and blue, varies much with the strength of illumination, so that each determination becomes invalid, where the illumination is considerably altered. Herr Brücke believes such a table might be useful in the colourless reproduction of paintings (drawings, copper-plate engravings, &c.). Further, he constructs a photometer, in which, instead of the brightness-table, he employs a variable illumination of the object to be distinguished from it.

THE specific gravity of liquid steel has been determined by Herr Alexjeff, by a method proposed by Herr Petruschewsky (*J. d. Russ. Chem. Phys. Ber.*, 12). A porcelain tube, open at both ends, was connected at one end with a forcing pump and a manometer, while the other end was immersed in liquid steel to a given depth (the tube vertical). On pumping, bubbles appeared at the latter end; and the indication of the manometer at that moment, compared with the depth of immersion, served for determination of the relative density of the steel and the liquid (naphtha) used in the manometer. The specific gravity of liquid steel was thus found to be 8·05, and so, greater than that of solid steel.

ACCORDING to Herr Antolik (*Wied. Ann.*, 3) very regular and pure Lichtenberg figures are obtained on spherical glass vessels filled with warm water at about 60° C. The surface can be made at will electrically positive or negative (which is not the case with ebonite or resin). Wires are inserted which are furnished with balls at their upper end. If positive electricity be introduced, electricity of that kind becomes free at the surface, and on dusting with Villarsy's mixture, a quite homogeneous sulphur layer is produced. Very regular discs appear on drawing sparks with the knuckles. A number of interesting effects are described by the author.

PROF. H. M. PAUL has communicated to the Seismological Society of Japan some notes on the effect of railway trains in transmitting vibrations through the ground. A box holding about twenty pounds of mercury thickened by amalgamation with tin, was placed upon a heavy plank screwed to the top of a post sunk 4½ feet into the ground. Images reflected in the surface of the mercury were observed by a telescope, as in meridian observations. An express train passing at a distance of one-third of a mile, set the surface of the mercury in confused vibration for two or three minutes. Other observations were made at stations at somewhat greater distances. The experimenter also found that a one-horse vehicle passing along a gravelled road 400 or 500 feet distant, caused a temporary agitation of the mercury whenever the wheels struck a small stone.

AN extremely valuable series of notes on physiological optics, from the pen of W. Le Conte Stevens, has lately appeared in the *American Journal of Science:* most of these relate to stereoscopic vision and the theory of the stereoscope. They are both too valuable and too full of matter to render full justice possible in a brief note.

A NEW form of refractometer, producing interference-bands and rings between two pencils of light which have traversed paths at right angles to each other, is described by Mr. A. A. Michelson in the *American Journal of Science.* In the path of a ray from a lamp, a piece of plane-parallel glass is interposed at 45°. The two pencils respectively reflected and refracted are then returned along their own paths by mirrors normal to each; and these returning rays unite at the point whence they parted, giving a resultant ray at right angles to the former path. The theory of this refractometer is deduced by Mr. Michelson, who devised this apparatus for use in his experiments to test the hypothesis of a relative velocity between the earth and the luminiferous æther.

M. VIOLLE finds the temperature of fusion of zinc free from lead, cadmium, arsenic, and other impurities to be 929·6° (C.); the value previously found by Edm. Becquerel was 932°; that given by Sainte-Claire Deville and Troost being 1040°.

THE rapidly-reversed currents generated in an ordinary Bell telephone do not sensibly affect the needle of a galvanometer even when the loudest tones are being sung into the instrument. Nevertheless M. Chardonnet has made the curious and interesting observation that during the short period while the note is increasing or diminishing in intensity, a deviation of the needle is observed. The explanation advanced is that during the rise or fall in intensity the alternate currents are no longer of equal strength, the odd semi-oscillations being either greater or less in amplitude than the even semi-oscillations during the period of rise or fall.

SOME interesting new pieces of acoustical apparatus have been recently described by Herr Hartmann (*Wied. Beibl.* No. 3). The *motorophone* shows the change of rotatory motion into

sounding motion, and the dependence of the qualities of the tone on the nature of the motion. A rapidly-rotated shaft has an adjustable eccentric with jointed rod, which at each rotation pulls a large drum-skin to and fro. A bell-mouth strengthens and concentrates the tones. The velocity of rotation determines the pitch; the eccentricity the strength of the tones. The *phonomotor* acts on the opposite principle, rotatory motion being got from vibration. In the *electromagnetophone* a piece of sheet-iron under an electromagnet has a point dipping in mercury; a current passing through the coils and the point becomes readily intermittent, and the membrane sounds. The *electromagnetic membrane-siren* is similar, but a solid sliding contact takes the place of the mercury, and a driving-wheel gives rapid interruption. Again, a tuning-fork is supported so as to be capable of rotation before a resonance-case. According to position it gives a strong resonance or a weak interference tone, the latter slightly higher. On rotating, the former becomes lower, the latter higher, and the dissonance ever greater. A *resonance-interference-pipe* is formed by connecting a caoutchouc tube with the nodes of an open pipe. If the tube be shortened by pressure at different parts, the tone of the pipe is raised or lowered through resonance-interference, is extinguished, or lets only the first overtone be heard. These instruments are made by G. F. Weigle, in Stuttgart.

CONTINUING his researches on "adsorption," or condensation of gases on surfaces of solids, Herr Kayser (*Wied. Ann.* No. 4) has studied the influence of the adsorbing material. The pressure was determined, which occurred in the glass vessel when given volumes of gas had been in contact with the solid material. The gases were carbonic acid, sulphurous acid, and ammonia, and these were adsorbed in the empty glass vessel, by coarse glass powder, and by turnings of brass and wrought iron. The metal-turnings were quite clean and unoxidised, and before each experiment they were heated *in vacuo* to about 300°, to remove gas. It was found that pressure was greatest, and so adsorption least, in the empty vessel. The order of increasing adsorption was, in general: empty vessel, iron, brass, and glass powder. By the empty vessel, SO_2 was least condensed, CO_2 and NH_3 about equally. Also, on the metallic surfaces, SO_2 always gave greater pressure than NH_3; between CO_2 and SO_2 there was hardly any difference. By the glass surfaces, on the other hand, CO_2 was comparatively little condensed, NH_3 considerably, and SO_2 to a large extent.

THE behaviour of mercury when polarised in contact with dilute sulphuric acid (as in Lippmann's well-known experiments), and with other acids and salt solutions, has been studied by Herr König at the instance of Prof. Helmholtz (*Wied. Ann.*, No. 5). The surface-tension, it is shown, reaches a maximum at a mean state of polarisation different for different liquids; the values diminishing on either side, as one removes from this, and both with positive and negative charges. Prof. Helmholtz offers some comments by way of theory on the phenomena.

FROM experiments at Würzburg (*Wied. Ann.*, No. 5), Mr. William Hallock infers the correctness of the view that the changes of electromotive force of the Smee element are due to action of polarisation. The electromotive force of polarisation is by no means independent (he affirms) of the nature of the electrodes, and it considerably exceeds that necessary for visible decomposition. The polarisation cannot be calculated from the heat phenomena.

To find whether the two coefficients used in equations of motion of incompressible liquids—one of viscosity, the other of variable adherence of the liquid to the walls—are independent of velocity, M. Elie (*Journ. de Phys.*, May) rotates a solid sphere within another filled with liquid, and hung bifilarly. The smaller sphere (0·04 m. diameter) is supported by a metallic wire passing through an aperture in the larger (0·12 m.) between the suspending wires to the vertical axis of an electric rotatory apparatus. During rotation (2 to 10 turns in a second) the hollow sphere is displaced to an amount indicated by a reflected light spot, and stops when the moment of the bifilar suspension balances that due to friction. In all the experiments with water, the reactions due to friction were found to increase more rapidly than the velocity; the ratio increased a third when the velocity was doubled; hence it appears that the viscosity or adherence, or both together, increase with the velocity.

THE name of *rheolyser* has been given by Prof. Wartmann to an apparatus (described in the *Archives des Sciences* for May) whereby the intensity of a derived electric current may be rapidly varied from zero to a maximum, and which indicates exactly the relation of those variations. A graduated metallic ring round a tripod-supported column encloses a thick disc of glass or ebonite, resting on the six radii of the ring. In the upper surface of the disc is a circular trough of mercury receiving two copper electrodes at the bottom, at a semicircle of interval. A cross-bar on the top of the column, on which it turns as axis, acts as a movable Wheatstone-bridge; it has two terminal verniers, and two screws dipping in the mercury; these latter are insulated, but communicate, through central binding screws, with a mirror galvanometer. The intensity of the derived current varies according as the bridge is displaced.

GEOGRAPHICAL NOTES

THE last work by Dr. E. Regel, on the Flora of Central Asia, which has recently appeared in the "Acta Horti Petropolitani" (vol. vii.), gives to Prof. Rehring, of Berlin, the opportunity of discussing the relations between the present flora and fauna of the North-eastern Asiatic Steppes, and the Post-glacial flora and fauna of Middle Europe. Prof. Regel, on the ground of his researches in Asia, arrived at the conclusion that out of the species which inhabited Central Asia during post-glacial times, very few have migrated towards north-western Asia and to Europe, and that the species now inhabiting this part of Asia have probably immigrated from Europe. The same was the conclusion arrived at several years ago by Dr. Rehring, when he and Dr. Liebe discovered in the Diluvium of Germany (at Westregeln and at Gera), a steppe-fauna much akin to the West Siberian (*Dipus jaculus*, *Arctomys bobac*, *Spermophilus altaicus*, *Lagomys pusillus*, *Equus caballus*, &c.), which facts led him to the inference that in post-glacial times middle Germany enjoyed a steppe vegetation and climate. The same steppe fauna has since been discovered at many other places in Germany, so that it may be said that the German diluvium encloses an unmistakable steppe fauna. Dr. Rehring discovers in Dr. Regel's work new proofs in favour of his theory of migration of the diluvial fauna from Europe to Asia, in opposition to the theory of the late Dr. Brandt, who considered North-western Asia as the true fatherland of the European diluvial fauna. We may observe that Dr. Rehring's theory would imply the migration of the German steppe fauna, not only to North-western Siberia, but also to Eastern Siberia, during the post-glacial period, which would involve several important difficulties. We believe that a true theory of the migrations of post-glacial faunas can be established only by taking into account the history of the glacial period in Asia, which history has never investigated.

DISCUSSING the character of the Glacial period on the Caucasus, M. Moushketoff points out (*Izvestia*, vol. xviii. fasc. 2), those features which are common to the former glaciers of the Caucasus, and those of the Zerafshan in Central Asia. He observes the present comparatively small extent of glaciers and snow-fields in both countries. The area now covered with perpetual snow on the Caucasus is very small (250 square kilometres) compared with the extent of the same regions in the Alps (more than 3000 square kilometres). The same relations—M. Moushketoff says—must have existed to some extent between both countries during the Glacial period, because of the greater dryness of climate on the Caucasus, and still more in Central Asia, in comparison with Western Europe. He concludes, in accordance with M. Abich and many others, that the ancient glaciers of the Caucasus had a far greater extension than the present ones (for instance, those of the Elbrouz reached, at least, down to 5200 feet, and the Baskan glacier united into one single mass all the present small glaciers which do not now descend lower than 6600 to 8600 feet). Nevertheless the glaciation was not so general as in Western Europe. This conclusion only must be provisional, the traces of the Glacial period having not yet been the subject of a thorough exploration, either on Caucasus or in Turkestan, whilst the obliteration of these traces has been far more complete in both these countries than in Europe. Taken in its widest sense, the supposition that the glaciation has been less intense in Middle Asia than in Europe seems very probable, and has been arrived at also by other explorers of Turkestan and Siberia.

BESIDES the Annual Address of the President, Lord Aberdare, reviewing the geographical progress of the year, the June number of the *Proceedings* of the Royal Geographical Society contains Mr. O'Donovan's paper on Merv; M. de Gorloff's account of